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Pollen Analysis of a Peat Deposit in Livingston County, Illinois

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The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner , included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight. W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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POLLEN ANALYSIS OF A PEAT DEPOSIT IN LIVINGSTON COUNTY, ILLINOIS

By CHARLES DONALD GRIFFIN[1]

This study essays to compare, and in some degree to supplement, pollen analyses thus far published for Illinois. Even though results of studies of fossil pollens seem very similar, each pollen profile is individual and varies in many details from all other profiles. For this reason, each new analysis is more than a repetition of what has already been studied and reported; it is a possible verification of these previous studies and a valuable supplement to the growing science of pollen analysis. It is hoped that the preliminary study of fossil diatom valves found in this deposit can be correlated with the fossil pollen record, and possibly reveal valuable additional data in the quest for information on the history of the pond and of climates of its vicinity.

Turtle Pond is situated in Livingston County, only a few miles from Chatsworth Bog which has been studied by Voss (22). Its exact location is in the southeast corner of Sec. 33, T. 26 N, R. 8 E. Since this was the only peat deposit in eastern Illinois which had been studied, it was considered of interest to make a comparison of the two.

PROCEDURE

The depth of Turtle Pond is 24 feet. Samples of the peat and sediments were obtained by means of a Hiller peat borer. The samples were taken at 12-inch intervals, placed in one-ounce vials, capped, labelled, and prepared for microscopic examination according to the Geisler alcoholic method (9). Identification of the fossil pollens were made from Wodehouse (23), Erdtman (6), and from prepared slides of modern pollens. At least 150 grains of the large trees were tabulated for each level unless the pollen frequency was exceptionally low. The percentage expressing relative abundance of a given genus (or species) is based either upon the first 150 or more grains encountered, or upon all grains found in ten slides.

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[1] A portion of a thesis submitted in partial fulfillmeut of the requirements for the degree of Master of Science in Botany in the Graduate College of the University of Illinois, 1950.

Valves of diatoms were abundant in this same material. The possibility of finding correlations between pollen profiles and diatom profiles suggested itself, even though effects of environmental changes upon the pond and upon the surrounding land areas might not show any considerable degree of parallelism. In order to find out whether any parallelism exists, diatoms in the slides examined for pollen counts were likewise identified and tabulated.

Because of their small size, the diatoms were studied with 10x oculars and a 90x oil immersion objective. Close to 100 valves were tabulated for each level except in certain levels with very low diatom frequency. The diatom percentages and frequencies are displayed in table IV.* The diatoms were identified from Boyer (2, 3), Elmore (5), Hustedt (14), Van Heurek (21), Smith (18), and Wolle (24).

RESULTS

The results of the pollen study are shown graphically in fig. 1 and in tables I and II. Examination of the graph reveals an early dominance by the pollens of the coniferous trees in the lower levels of the sediment. The 23- and 24-foot levels are devoid of pollen but the 22-foot level reveals a few grains. In the 21-foot level, there is a sudden appearance of coniferous pollens and in the 20-foot level there is a great increase in the pollen frequency.

Picea mariana is the most abundant species in the lower levels and *P. glauca* is next. *P. glauca,* however, shows its highest percentage of abundance at a point of high pollen frequency (18-ft. level) while the maximum percentage for *P. mariana* comes after that of *P. glauca* (in relation to sediment accumulation and during a time when the pollen frequency is declining (15-ft. level)).

Species of Pinus are poorly represented in the lower levels, although *P. strobus* has its second highest percentage at the 20-foot level. It may be pointed out that the pollen frequencies were so low at the 1- to 5- and 21-foot levels that, although percentages were tabulated and charted, they are probably unreliable. To the extent that

* Because of expense involved, tables of the original thesis are not here published. They may be consulted in the thesis which is on file in the University of Illinois library.

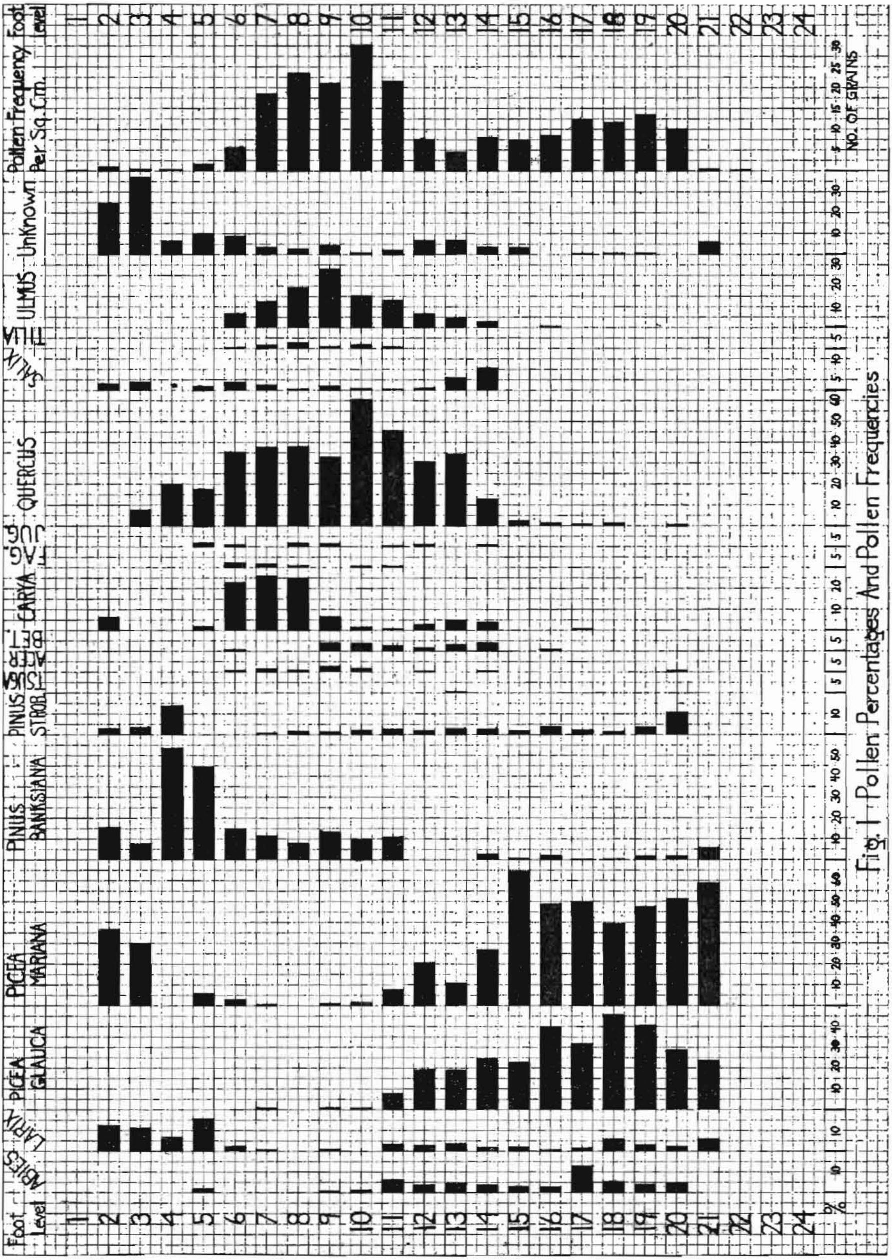

Fig. I Pollen Percentages And Pollen Frequencies these counts are reliable, it may be of significance that *P. banksiana* reached a maximum of 54% at the 4-ft. level when the broadleaf genera were represented only by Quercus (20%) and that this followed a second prairie invasion as shown by high frequency of grass and chenopod pollens during the 7- to 5-ft. levels. Larix is more frequent in the lower levels than in the upper. Abies shows a maximum percentage at the 17-foot level. After the maximum for *Picea mariana* at the 15-foot level, there is a rapid decline in the coniferous pollens and a striking increase in those of the broad-leaved genera (especially Quercus).

There is a great increase in the number of grass, chenopod and willow pollens in this zone of transition (14-13-foot levels) between dominance by conifers and dominance by broad-leaved genera, as may be seen in fig. 1 and table II. There is also a decrease in pollen frequencies during this interval. Above the 13-foot level there is a great increase in pollen frequencies with almost complete disappearance above the 11-foot level of coniferous pollens (except for a rather uniform representation of Pinus) followed by increase in oak, elm, hickory, and linden.

The higbest pollen frequency occurs at the 10-foot level. This is the level of oak maximum. Mollusk shells and pollens of Nymphaea were also observed at the 10-foot level. From the 10- to the 6-foot level, pollen frequencies decline. This decline is almost wholly that of broad-leaf tree pollens. The maximum for Ulmus is at the 9-foot level, while Carya, sparingly present from the 14- to 9-foot levels, is well represented (surpassed only by Quercus) at the 8-, 7-, and 6-foot levels.

At the 6-foot level, there is a second occurrence in considerable numbers of grass, chenopod, buttonbush, and cattail pollens. Thus at two depths, one in the interval of conifer decline and broad-leaved increase and the other just after the decline of broad-leaved genera, there is a maximum pollen representation for shrubs and herbs. Tsuga, Acer, Betula, Fagus, and Juglans are sparsely represented by pollens and appear with the dominant broad-leaved Quercus, Carya and Ulmus.

The results of the preliminary diatom counts are shown in table IV. This table shows the percentages of diatoms located in each foot level and the diatom frequency per square centimeter in each foot-level. It can be seen that some species are more frequent at one level than at another and that some species are present only in certain levels or series of levels.

SIGNIFICANCE OF THE RESULTS

Comparison of profiles of Turtle Pond and Chatsworth Bog show that they are quite similar in composition of pollen. Excluding the upper 5 feet and lower 4 feet from the Turtle Pond boring (in which the pollen frequencies are very low and results unreliable), there are 15 feet of peat that can be favorably compared with the Chatsworth. In both locations, the lower levels indicate a cool moist climate at the beginning of pollen accumulations after the retreat of the ice from this area. This is presumed because of the abundance of conifer pollens, especially of Picea. There is an initial maximum in pollen frequency of both bogs during this coniferous period. This pollen-count maximum for all species represented holds from the 19-foot through the 17-foot level at Turtle Pond. A decrease from the 16- to 13-foot levels is followed by a second increase, this time in deciduous-tree pollens, with highest pollen count at the 10-foot level. A decrease in pollen frequencies also occurs in the Chatsworth profile between the initial conifer abundance and an abundance of deciduous-tree pollens.

There is no indication (due to lack of herbaceous pollens) of a tundra vegetation having invaded this area shortly after the waning of the ice. However, with decrease of the conifer pollen and the corresponding decrease in pollen frequency, Voss reports, for the Chatsworth Bog, that Ambrosia pollen is exceedingly abundant. Similar results were obtained at Turtle Pond, in which, at this level of low pollen frequency, there appears a high percentage for herbaceous pollens (table II). Voss discounts the possibility that the Ambrosia pollen may indicate a drier period than the preceding period of conifer dominance. Preservation of Ambrosia pollen was attributed to a greater resistance to decay. He interpreted vegetational change in Illinois as merely a gradual change from conifer to broad-leaved genera. The present study suggests a somewhat different interpretation.

The Turtle Pond profile tends to substantiate the occurrence of two xeric periods in which there were fewer trees and many shrubs.

It is concluded that this part of Illinois was twice invaded by herbaceous species forming a prairie over a sizeable proportion of the general area. The conifers, south of the ice margin, had presumably advanced northward after the retreating Wisconsin ice and, due to consequent drier and warmer conditions, the coniferous forest was at least over part of its area replaced by prairie vegetation. This is one of the vegetational changes suggested by Gleason (11) from other evidence. If this conclusion is correct, the area of herbaceous cover was later, in part, re-invaded by forest, but this time by trees of the deciduous species. The gradual entrance of deciduous species began at the same time that conifers began their decline (the 14-foot level at Turtle Pond). Decline of conifers was nearly complete (at the 11-foot level) before the broadleaf pollen maximum (10-foot level). These facts by themselves conform to Voss' idea of gradual change from conifers to broadleaf genera. If, however, there had been no diminution in forest coverage, we should similarly find no diminution in pollen frequency in the period represented by 16- to 12-foot levels. The minimum pollen count is at the 13-foot level. This long period of low tree-pollen counts coincides with the first maximum for pollens of grasses and chenopods (see table II). There seems to be little reason for doubting the possibility that prairie could have occupied much of the area during this period. The second increase of prairie presumably accompanies the decline of deciduous pollen in the 7- to 5-foot interval. The upper part of the profile (1- to 5-foot levels) is not dependable since uear-surface conditions in recent times may have destroyed pollens originally present. Certainly, the herbaceous cover was in nearly complete possession of this central part of the Illinois Grand Prairie at the time of immigration of the first Europeans.

Several climatic interpretations of the Turtle Pond pollen profile may be assumed. It is evident that changes in the vegetation-types, which at successive times contributed the largest quota of pollens, were from conifers, to herbs, to broadleaf tree genera, to herbs. A major distinction between grassland and forest, as reported by Transeau (20), is based largely upon difference in available moisture and its seasonal distribution. Pollens from a combination of coniferous genera suggest cooler climate than from a combination of broad-leaf tree genera. The climatic stages indicated by the pollen profile are thus: cool-moist, to warm-dry, to warm-moist, to warm-dry.

From the work of various Scandinavian botanists and geologists, there has heen established the Blytt-Sernander hypothesis of the succession of postglacial climates. This scheme applies specifically to northwestern Europe, although the hasic climatic changes it implies are common to a far wider range (Flint. 7). The similarity of this hypothesis to the climatic sequences represented by the Turtle Pond pollen profile is striking. The suggested correlation is represented in tahle II. The significance of high pollen percentages for Typha and Cephalanthus at the 6-foot level is not readily determined. Possihly the water level of the pond became lower at this time, thereby exposing a greater area favorable for extensive development of these genera. Due to low pollen frequencies in the 1- to 5-foot levels and the absence and sparseness of pollens in the 22- to 24-foot levels, no direct correlation of these levels can be made with the Blytt-Sernander phases. The arctic phases in Europe are correlated with the appearance of pollens characteristic of tundra plants. As stated previously, no evidence of tundra is found in Turtle Pond.

It is difficult to correlate climatic changes indicated in the pollen profile with the Wisconsin glacial substages. Turtle Pond is located on drift of the Tazewell substage. If succeeding substages, the Cary and Mankato, were initiated with major climatic changes, these should be recorded in the profile. However, the truncated records of Turtle Pond and Chatsworth Bog may not include climatic changes during each of these substages. Further pollen analyses are needed from this area to substantiate a more definite relationship between vegetational and climatic (glacial) history.

Woodward (25) presents an interesting discussion on the presence of tundra next to the ice front. Although the present study gives no support for this supposition, it is not entirely unlikely, since the lower levels of the sediment reveal neither spores nor pollen. This could be due to unfavorable conditions for the preservation of microfossils at this time or to the possibility that this "kettle hole" was not an open stand of water immediately following the ice retreat. Pollen spectra in North America, unlike those of Europe, have not shown evidence of tundra vegetation at the beginning of sediment accumulation in the bogs.

Comparing Turtle Pond with bogs on Early Wisconsin (Tazewell) drift in Indiana, several similarities are noted. One is the sparseness of Tsuga pollen. Another is the later entrant into the forest complex of Carya than of Quercus. Pinus is persistent to the upper levels in the bogs of Early Wisconsin glaciation but never shows a definite climax. This is true in Turtle Pond regardless of the fact that there is a climax at the 4- and 5-foot levels on the graph. As stated previously, the first five levels at Turtle Pond are extremely sparse in pollen grains and the percentages given are unreliable. However, Pinus appears to be on the increase in the upper foot-levels of this peat deposit. Another similarity is that *Picea glauca* reaches a climax between maxima of *P. mariana*.

Bogs of the Early Wisconsin glaciation in Indiana have been studied by Barnett (1), Friesner and Potzger (8), Griffin (12), Howell (13). Otto (15), Prettyman (16), Richards (17), and Swickard (19).

Because of a study by Geisler (10), an attempt was made to separate grass pollens on the basis of size and exine thickness in order to determine the prairie species. However, the fossil grass pollens were too crushed to give accurate size measurement and the results of the measurements were omitted from the table.

The preliminary diatom study (table IV) is inconclusive because there are no other studies of fossil diatoms reported from this area. So, there is no comparison to be made. Some of the diatom species are characteristic in their presence or abundance at certaiu levels and may be correlated with certain events disclosed by the pollen spectrum (table I). It is hoped that with future analyses, the significance of the diatoms can be correlated with the history of climate in Illinois. A far more extensive study of micro-fossils from the numerous bogs in Illinois must be undertaken before any generalized statement can be made as to the climatic and vegetational changes which have occurred since the glacial retreat.

SUMMARY AND CONCLUSIONS

1. Conifer pollens were dominant in the lower foot-levels, reaching over 90% at the 16- and 15-foot levels.

2. *Picea mariana* was the dominant conifer throughout the profile except at the 18-foot level where it was exceeded hy *P. glauca*.

3. As Picea declined from its dominance, Quercus made its appearance, reaching its peak of 61% at the 10-ft. level, where the decline of conifers was nearly complete.

4. *Pinus strobus* never played an important role in the area around this bog.

5. Carya and Ulmus increased as Quercus declined from its 10-ft. peak, but at no foot-level did they exceed Quercus.

6. Except for the top 5 foot-levels where the results are probably unreliable, pollen frequency was lowest at the 13-ft. level. Maximum frequency was reached at the 10-ft. level.

7. The long period of low frequency of tree pollens (16- to 12-ft. levels) coincides with the first maximum for pollens of grasses and chenopods, indicating the possibility of a prairie invasion.

8. A second increase of prairie may be indicated by the decline in deciduous tree pollen in the 7- to 5-ft. interval.

9. The vegetational succession appears to have been from conifers to herbs to broadleaf trees to herbs.

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